Water Management in Ontario

Publication No. 1

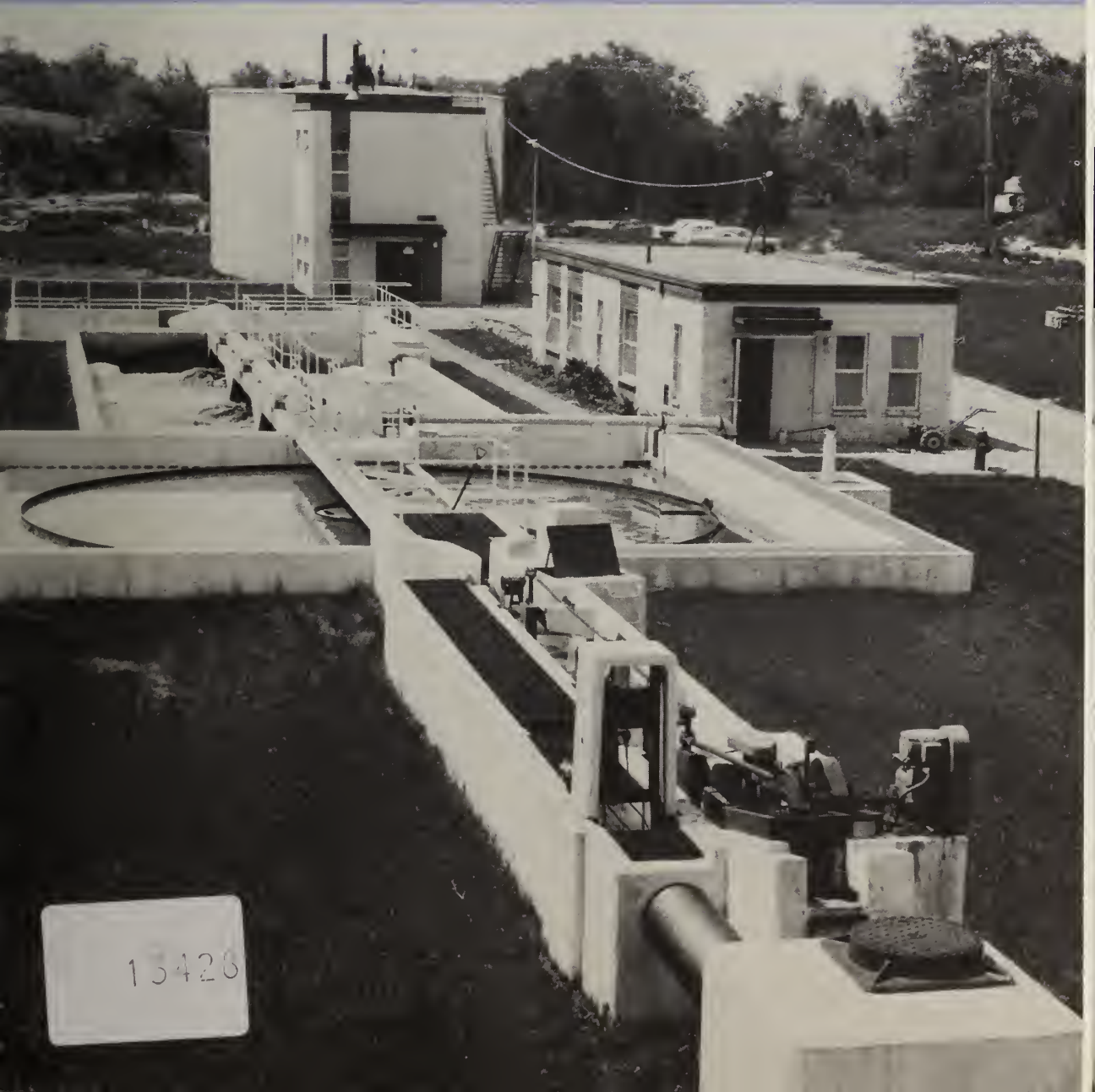
Design Approvals Branch
Division of Sanitary Engineering

Ontario Water Resources Commission
135 St. Clair Ave. W., Toronto 7, Ontario

A Guide on Estimating

SEWAGE TREATMENT PLANT CONSTRUCTION COSTS

in the Province of Ontario



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A GUIDE ON ESTIMATING SEWAGE TREATMENT PLANT CONSTRUCTION COSTS IN THE PROVINCE OF ONTARIO

ONTARIO WATER RESOURCES COMMISSION

801 Bay Street, Toronto 5

1967

FOREWORD

The Ontario Water Resources Commission through its approval certificates maintains records of sewage works costs in the Province. By the publication of this guide it is hoped that the information presented will assist engineers, architects, planners and developers, and municipal officials in the preparation of better preliminary cost estimates for sewage treatment works.

The guide includes the cost of sewage treatment plants using standard treatment processes. It does not however, include gravity sewers, sewage pumping stations and sewage treatment plants utilizing recently developed treatment processes. Costs of these works will be presented in succeeding publications.

It has been prepared by the staff of the Design Approvals Branch, Sanitary Engineering under the supervision of Mr. A. R. Townshend, P.Eng. Mr. A. E. Goodwin, Director, Electronics Computing Branch, Department of Highways, Ontario, authorized the use of its computors for handling the data. The regression curves were determined by Miss June Gardiner, Scientific Programming.

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1.0 INTRODUCTION

It is important that reliable cost estimates be available during the early stages of any proposed sewage works project. With this information, the municipality or private owner can: (1) determine whether the proposed project can be afforded initially; (2) plan the method of financing to be used; and (3) if necessary, develop an acceptable staged programme. In addition, the engineer or architect might: (1) estimate the most economical method of treatment without going into detailed design and (2) judge the validity of competitive bids when tenders are received. These examples of the usefulness of accurate construction cost estimates and the fact that actual costs are not available until a contract has been awarded demonstrate the need for a reliable method of obtaining costs during the early stages of the project.

In the United States, cost studies were first published in 1958 by the United States Public Health Services. These cost data were compiled from a very limited number of sewage treatment plants. From 1958 to 1961, cost studies were done on Imhoff tanks, conventional primary treatment plants with separate sludge digestion, waste stabilization ponds, high-rate trickling filters, and activated sludge treatment plants using the Engineering-News Record Construction Cost Index. In 1964, the United States Public Health Services published a guide entitled "Modern Sewage Treatment Plants - How Much Do They Cost?" using its own sewage treatment plant index.

This guide on sewage treatment plant construction costs in Ontario is based on cost estimates taken from the Department of Health and Ontario Water Resources Commission approval certificates. The E.N.R. Construction Cost Index was selected to up-date all costs to 1965 prices. The least squares method was used to determine the line of best fit for the available data and statistical procedures were used to determine the standard error of estimate. The guide gives an example on the use of the graphs and discusses limitations of the cost estimating data. The Appendix contains an example of the least squares calculation for Graph No. 1 - Primary Treatment Plants. The tables and graphs of the various treatment processes studied follow the appendix.

2.0 SELECTION OF A CONSTRUCTION COST INDEX

An index is a statistical measure designed to show changes in a variable or a group of variables with respect to time, location or other characteristics. By using index numbers a comparison of costs from one year to another for a particular facility can be made.

Three such indexes were considered for use in this study. These were the Engineering News Record Construction Index, The Southam Construction Cost Index and the United States Public Health Services Sewage Treatment Plant Index.

2.1 THE E.N.R. CONSTRUCTION COST INDEX

The E.N.R. Construction Cost Index was established in 1921 to diagnose and track the fluctuation in prices after World War I. It was based on a hypothetical block of construction priced weekly and valued at $100 in 1913 prices.

The E.N.R. Index adjusts the cost of any particular period to the base year of the Index 1913 = 100. The Index is priced monthly for 20 U.S. cities, Toronto and Montreal.

2.2 THE SOUTHAM CONSTRUCTION COST INDEX

The Southam Construction Cost Index is calculated from material and wage indexes for four centres, Montreal, Toronto, Winnipeg and Vancouver.

Spot prices for cement, brick, steel channels and framing lumber are averaged for these four cities. The Southam Construction Cost Index adjusts the cost of any particular period to the base year of the Index 1949-50 = 100.

2.3 THE UNITED STATES PUBLIC HEALTH SERVICE SEWAGE TREATMENT PLANT INDEX

The United States Public Health Service investigated the E.N.R. Index and concluded that:

(1) It does not include the most important commodities used in sewage treatment plant construction, i. e. process equipment and skilled labour.

(2) It does not represent materials cast-in-place or even on the job, which could differ substantially from the wholesale prices of these same materials.

(3) It uses a weighing that is not representative of modern design and construction practices.

The U.S.P.H.S. devised its own index based on a hypothetical 1.0 mgd high-rate trickling filter plant, designed to serve a population of 10,000 persons. The cost estimates of this plant were predicted on idealized conditions, representing minimal costs under circumstances prevailing in Kansas City, Missouri. The U.S.P.H.S. Index adjusts the cost of any particular period to the base period 1957-59 = 100.

2.4 COMPARISON OF INDEXES

A comparison was made of these three indexes to determine which one was most suitable for use in Ontario. All three indexes were converted to a common base period of 1957-59 = 100. This was done by using simple ratios. For example, the value of the E.N.R. Index for the year 1930 (using base period 1913 = 100) is 170. The average value of the E.N.R. Index for the period 1957-59 is 615. Therefore, the value of the E.N.R. index for the year 1930 using the base period 1957-59 = 100 is $\frac{170}{615} \times 100$ or 28.6

In addition to these three indexes, a fourth curve was derived from the estimated costs of 1.0 mgd conventional activated sludge plants in Ontario. All four curves are shown on Figure 1, page 35.

From 1945 to 1960, the three indexes followed similar trends. However, from 1960 to 1965, the U.S.P.H.S. Index appeared to level off whereas, the E.N.R. and Southam indexes continued to increase. The index derived for Ontario sewage treatment plant construction costs gave a steeper slope resulting in lower values prior to the base period and higher values after the base period.

Since the E.N.R. Construction Index appeared to be as reliable as any other index, it was selected.

3.0 DERIVATION OF COST GRAPHS

The cost graphs of the various sewage treatment works given in this guide were derived from the basic data by using the E.N.R. Construction Index to convert all costs to the base year of 1965 and by employing the least squares method as described in this chapter.

3.1 SOURCE OF DATA

The plant capacities and cost data used in this guide were obtained from the applications and approval records of the Department of Health and the Ontario Water Resources Commission. The costs are estimated costs which may have been prepared from one to two years prior to approval and/or construction.

3.2 PLANT CAPACITY AND ADJUSTED UNIT COST TABLES

The parameters capacity, and dollars per gallon per day were selected for the mechanical plants and acreage and dollars per acre for the waste stabilization ponds. For each process all plants were listed in a table alphabetically by municipality and given a graph number. Next, the associated parameters and approval numbers or year built were added. All project costs were up-dated to 1965 costs using the E.N.R. Index for Toronto of 800. This was done by multiplying the estimated cost of the project by the ratio of the 1965 E.N.R. Index to the E.N.R. Index for the year the facility was approved or built.

3.3 FITTING THE DATA BY THE LEAST SQUARES METHOD

The least squares method as adopted by the U.S.P.H.S. for its studies on sewage costs was used to fit the data. It was assumed that the sample distribution could be represented by the equation -

$$\log Y = a + b \log X \qquad (1)$$

The line of best fit for each sample distribution was determined by solving the following two normal equations:

$$Na + b\Sigma X = \Sigma Y \qquad (2)$$

$$a\Sigma X + b\Sigma X^2 = \Sigma XY \qquad (3)$$

where

N = number of observations
ΣX = sum of the logarithms of the capacity
ΣX = sum of the squares of the logarithms of the capacity
ΣY = sum of the logarithms of unit cost
ΣXY= sum of the cross products of logarithm X and logarithm Y
a = Y intercept
b = slope of the line

and substituting the values of the constants "a" and "b" into equation (1). This equation then represents the regression or estimating curve for the sample distribution.

The degree of relationship between the two variables used in each sample distribution was determined from the correlation co-efficient. The co-efficient varies between -1 and +1 and is a good measure of the lineal correlation between the two variables.

As previously mentioned, equation (1) represents the curve of best estimate for the sample distribution. A measure of the scatter about the regression line is supplied by the standard error of estimate of Y on X. This is given by the equation

$$\sigma_{Y.X} = \sqrt{\frac{\Sigma(\log Y - \log Y_{est})^2}{N}} \qquad (4)$$

If lines are constructed parallel to the regression curve of Y on X at respective vertical distances $\sigma_{Y.X}$ (one standard deviation), the limits which include 68% of the sample distribution are defined.

4.0 USE OF THE COST GRAPHS

To illustrate the use of the curves as a guideline in estimating construction costs of sewage treatment plants, it is assumed that the May, 1967 estimated average cost of a 10 mgd primary sewage treatment plant is required, given the corresponding Toronto May, 1967 E.N.R. Index is 882.35.

From Graph No. 1, the average cost of a 10 mgd primary plant would be 19.54 cents per gallon or $1,954,000 in 1965 dollars. Since these curves have been developed using 1965 dollars, it is necessary to up-date the estimated cost using the E.N.R. Index. Using the May, 1967 Index of 882.35, the estimated average construction cost in 1967 dollars would be $\frac{882.35}{800} \times 1{,}954{,}000$ or $2,149,000.

The range in which the estimated costs are expected to fall 2/3 of the time may be determined by reading off the upper and lower limit values given in the graph for the 10 mgd primary plant. These values are 13.03 cents per gallon and 29.30 cents per gallon, respectively, for a total estimated cost between $1,342,000 and $3,080,000 in 1967 dollars.

5.0 LIMITATIONS OF COST ESTIMATING DATA

So that the cost curves may be used most effectively by engineers, architects, planners, developers and municipal officials, the following limitations should be appreciated:

1. In almost all cases, the estimated costs given are for the complete installation including, where provided, such items as raw sewage pumping facilities, foundation piles, and outfall sewers.

2. For the complex plants, the estimated costs are not broken down by individual processes such as pre-treatment, primary treatment, and sludge treatment.

3. Similarly, no breakdown in cost is given for such items as materials, mechanical equipment, and labour.

4. Except where noted the estimated costs given by the curves do not include land charges, engineering, and contingencies.

5. Again, the costs given are mainly based on estimated costs which may have been prepared from one to two years before the final approval is issued and the plant is built. No allowance was made for this factor in converting to 1965 costs using the E.N.R. Index.

6. The estimated cost curves cover only limited plant capacities. Therefore, the curves should be used only within the ranges shown as there is no statistical basis for extrapolation.

7. It is suggested that the most accurate estimates can be made by comparing plants of equal capacity having similar design and construction features. For this reason, the plants were numbered in the tables and were shown on the graphs. Those who are familiar with comparable installations in Ontario will, therefore, be able to use this feature to best advantage.

With the exception of waste stabilization ponds, the statistical evaluations of sewage treatment plant construction costs in this guide are based on cost per unit flow. Per capita costs may be approximated from the curves by using a conversion factor of 100 gallons per capita per day.

For graph Nos. 2 and 3 on septic tanks and filters, respectively, where less than 30 facilities were available for determining the line of best fit, they should be used with particular caution, since they have little statistical validity. These graphs in particular will be revised when more data become available.

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APPENDIX

EXAMPLE OF COST ANALYSIS

The following example illustrates the method used to derive the equations and the limits which are given in the following graphs and tables.

Data from 26 projects (primary treatment plants) were available. The following values were tabulated from the available information:

$$N = 26$$

$$\Sigma X = 9.3719198$$

$$\Sigma Y = 36.7331088$$

$$\Sigma X^2 = 13.3868237$$

$$\Sigma Y^2 = 53.0032688$$

$$\Sigma XY = 11.3331341$$

where

N = number of plants

ΣX = sum of logarithms of the design flow

ΣX^2 = sum of squares of logarithms of design flow

ΣY = sum of logarithms of unit costs

ΣXY = sum of the cross product of the logarithms of design flow and unit costs

These values are substituted into the following normal equations:

$$Na + b\Sigma X = \Sigma Y \qquad - (1)$$

$$a\Sigma X + b\Sigma X^2 = \Sigma XY \qquad - (2)$$

The resulting equations are:

$$26a + 9.3719198b = 36.7331088 \quad - (3)$$

$$9.3719198a + 13.3868237b = 11.331341 \quad - (4)$$

Where

$a = 1.4815145$

$b = 0.190598$

Hence, the resulting equation of the regression curve is:

$$\text{Log } Y = 1.4815145 - 0.190598 \text{ Log } X$$

In order to determine the standard error of estimate of Y on X, the following data is required:

X	Y	Log Y	(Log Y - Log $\bar{Y}$)	(Log Y - Log $\bar{Y}$)^2
3.00	21.6	1.3344537	-.0783582	.0061400
1.00	34.4	1.5365584	.1237465	.0153132
7.50	14.4	1.1583625	-.254494	.0647672
1.00	54.4	1.7355989	.3227870	.1041914
0.67	15.2	1.1818436	-.2309683	.0533464
1.80	28.8	1.4593925	.0465806	.0021697
6.00	26.4	1.4216039	.0087920	.0000773
60.0	12.0	1.0791812	-.3336307	.1113094
0.30	40.0	1.6020600	.1892481	.0358148
0.50	36.0	1.5563025	.1434966	.0205913
4.00	45.6	1.6589648	.2461529	.06059125
11.50	12.0	1.0791812	-.333607	.1113094
2.00	12.0	1.0791812	-.333607	.1113094
0.50	40.0	1.6020600	-.1892481	.0358148
0.70	20.0	1.3010300	-.1117819	.01249519
10.00	31.2	1.4941546	.0813427	.0066166
0.19	50.4	1.7024305	.2896186	.0838789
0.75	21.6	1.3344537	-.078352	.0061400
40.00	14.4	1.1583625	-.2544494	.0647444
3.00	27.2	1.4345689	.0217570	.0004736
0.57	46.4	1.6665180	.2537061	.0643667
2.00	46.2	1.6665180	.2537061	.0643667
8.00	16.0	1.5465427	.1337308	.0178839
8.00	35.2	1.2041200	-.2086919	.0435523
1.00	26.4	1.4216039	.008792	.0000773
4.00	20.8	1.3180633	-.0947486	.0089772

$\Sigma X = 177.98$

$\Sigma \text{Log } Y = 36.7331088$

$\text{Log } \bar{Y} = 1.4128119$

$\Sigma (\text{log } Y - \text{log } \bar{Y})^2 = 1.1062965$

Y_{est}	Log Y_{est}	(Log Y_{est} - Log $\bar{Y}$)	(Log Y_{est} - Log $\bar{Y}$)^2
24.5797	1.38058	-.03223	.0010388
30.3050	1.48159	.06878	.0047306
20.6409	1.31471	-.09810	.0096236
30.3050	1.48159	.06878	.0047307
32.7088	1.51468	.10187	.0103775
27.0932	1.43152	.01871	.0003501
21.5378	1.33345	-.07936	.006298
13.8868	1.13239	-.28042	.0786354
38.1219	1.58115	.16834	.0283384
34.5852	1.53895	.12614	.0159113
23,2682	1.36680	-.04601	.0021169
19.0260	1.27944	-.13337	.0177876
26.5545	1.42406	.01125	.0001266
34.5852	1.53895	.12614	.0159113
32.4368	1.51108	.09827	.0096570
19.5396	1.29092	-.12189	.0148572
41.5894	1.61899	.20618	.0425102
32.0131	1.50515	.09234	.0085267
15.0026	1.17609	-.23672	.0560364
24.5797	1.38058	-.03223	.0010388
33.7322	1.52802	.11521	.0132733
26.5545	1.42406	.01125	.0001266
20.3886	1.30942	-.10339	.0106895
20.3886	1.30942	-.10339	.0106895
30.3050	1.48159	.06878	.0047307
23.2682	1.36680	-.04601	.0021169

$$\Sigma (\text{Log } Y_{est} - \text{Log } \bar{Y})^2 = 0.3635895$$

Where

$\log \bar{Y} = \frac{\Sigma \log Y}{N}$

$\Sigma (\log Y - \log \bar{Y})^2$ = total variation

$\Sigma (\log Y_{est} - \log \bar{Y})^2$ = explained variance

$\Sigma (\log Y - \log Y_{est})^2$ = unexplained variance

and

$$\Sigma (\log Y - \log \bar{Y})^2 = \Sigma (\log Y - \log Y_{est})^2 + \Sigma (\log Y_{est} - \log \bar{Y})^2$$

therefore

$$\Sigma(\log Y - \log Y_{est})^2 = \Sigma(\log Y - \log \bar{Y})^2 - \Sigma(\log Y_{est} - \log \bar{Y})^2$$

Using the following equation,

$$\sigma_{Y.X} = \sqrt{\frac{\Sigma(\log Y - \log Y_{est})^2}{N}}$$

(where N = the number of degrees of freedom)

the value of the standard error of estimate is

$$\sigma_{Y.X} = \sqrt{\frac{(1.1062965 - .3635895)}{24}} = .175915$$

Using the equation of the regression curve

$$\log Y_{est} = 1.4815145 - 0.190598 \log X$$

then for X= 10.0, the value of $\log Y_{est} = 1.29092$

and $Y_{est} = 19.0260$

In order to determine the upper and lower values, one standard deviation is taken about the estimated value.

therefore

$$\log (Y_{est})_{\text{upper value}} = 1.291 + 0.176 = 1.467$$

$$\log (Y_{est})_{\text{lower value}} = 1.291 - 0.176 = 1.115$$

Y_{est} = 19.5396

$Y_{(est)}$ upper value = 29.30

$Y_{(est)}$ lower value = 13.03

Ratio of upper limit = $\frac{29.30}{19.54}$ = 1.499

Ratio of lower limit = $\frac{13.03}{19.54}$ = .667

The correlation coefficient is given by

$$r = \overset{+}{-} \sqrt{\frac{\text{explained variation}}{\text{total variation}}} = \overset{+}{-} \sqrt{\frac{\Sigma(\log Y_{est} - \log\bar{Y})^2}{\Sigma(\log Y - \log \bar{Y})^2}}$$

(The signs $\overset{+}{-}$ are used for positive linear correlation and negative correlation, respectively).

Therefore

$$r = \sqrt{\frac{0.3635895}{1.1062965}} = .5732841$$

TABLE 1

CONSTRUCTION COSTS FOR PRIMARY TREATMENT PLANTS

(Land Charges and Engineering Excluded)

(Toronto E.N.R. Index (1965) = 800)

MUNICIPALITY	GRAPH NO.	YEAR BUILT	TORONTO E.N.R. INDEX YEAR BUILT	PLANT CAPACITY (M.G.D.)	TOTAL COST YEAR BUILT	1965 CENTS PER GALLON PER DAY
BELLEVILLE	1	1961	688	3.00	$ 550,000	21.6
COLLINGWOOD	2	1960	673	1.00	290,000	34.4
CORNWALL	3	1962	712	7.50	950,000	14.4
ELLIOT LAKE (TWP)	4	1957	596	1.00	408,700	54.4
ESPANOLA	5	1961	688	0.67	86,575	15.2
FORT ERIE	6	1962	712	1.80	458,000	28.8
FORT WILLIAM	7	1962	712	6.00	1,400,000	26.4
HAMILTON	8	1958	607	60.00	5,614,000	12.0
INGLESIDE	9	1956	558	0.30	85,200	40.0
IROQUOIS	10	1956	558	0.50	125,000	36.0
KITCHENER	11	1930	170	4.00	390,000	45.6
KITCHENER	12	1958	607	11.50	1,037,000	12.0
LINDSAY	13	1950	400	2.00	122,000	12.0
MORRISBURG	14	1956	558	0.50	180,000	40.0
NAPANEE	15	1953	525	0.70	90,000	20.0
NIAGARA FALLS	16	1962	712	10.00	2,829,000	31.2
NIPIGON (TWP)	17	1955	543	0.19	65,000	50.4
ORANGEVILLE	18	1959	642	0.75	128,000	21.6
OTTAWA	19	1961	688	40.00	4,750,000	14.4
OWEN SOUND	20	1961	688	3.00	700,000	27.2
POINT EDWARD	21	1960	673	0.57	220,000	46.4
PORT ARTHUR	22	1958	607	2.00	708,311	46.4
SARNIA	23	1958	607	8.00	2,123,250	35.2
SAULT STE. MARIE	24	1960	673	8.00	1,109,000	16.0
TRENTON	25	1957	596	1.00	194,700	26.4
WATERLOO	26	1959	642	4.00	660,000	20.8

TABLE 1-A

CONSTRUCTION COSTS FOR PRIMARY TREATMENT PLANTS

VARIABLES

X - Plant Capacity in million gallons per day (m. g.d)

Y - Construction Costs in 1965 cents/per gallon per day (cents/GD)

Model - $\log Y = a + b \log X$

Equation - $\log Y = 1.4815145 - 0.190598 \log X$

Valid Range of X - .30 to 60.00 M.G.D.

Correlation Coefficient - 0.57

Standard Error of Estimate - 0.175915

Ratio for upper limit - 1.4994

Ratio for lower limit - 0.6669

VALUES FOR PLOTTING

X	- Y -		
	Lower Limit	Expected Value	Upper Limit
1	20.21	30.31	45.45
3	16.39	24.58	36.86
10	13.03	19.54	29.30

TABLE 2

CONSTRUCTION COSTS FOR
SEPTIC TANK & UNDERDRAINED TILE BEDS

(Engineering Costs Included)
(Land Charges Excluded)

Toronto E.N.R. Index (1965) = 800

MUNICIPALITY	GRAPH NO.	OWNER	APPROVAL NUMBER	CAPACITY G.P.D.	COST IN 1965 DOLLARS	1965 DOLLARS PER G.P.D.
ALBION TWP	1	Mackville Public School	63-A-755	2,160	8,620	4
BRANTFORD TWP	2	Brantford Plaza	62-A-675	14,800	25,270	1.71
CLINTON TWP	3	Nipponia Home for the Aged	62-A-783	2,700	8,830	3.27
DORCHESTER S. TWP	4	School	65-A-777	5,000	10,000	2.00
EUPHEMIA TWP	5	Central School	65-A-724	3,150	4,850	1.54
FLAMBOROUGH W. TWP	6	Restaurant	1961 letter only	1,200	3,390	2.82
HAY TWP	7	Bluewater Rest Home	65-A-592	3,750	5,000	1.33
OAKVILLE	8	Palermo Public School	65-A-525	4,500	17,600	3.91
PITTSBURGH TWP	9	Cana Home Builders	54-A-358	5,000	15,700	3.14
ROMNEY TWP	10	Central School	64-A-610	6,300	20,720	3.30
SOUTHWOLD TWP	11	Central School	64-A-325	2,600	3,570	1.37
THOROLD TWP	12	United Steel Corp.	63-A-907	2,750	19,250	7.0
TORONTO TWP	13	Meadowdale Public School	65-A-220	9,000	19,000	2.11

TABLE 2-A

CONSTRUCTION COSTS FOR SEPTIC TANK AND UNDERDRAINED TILE BEDS

VARIABLES

X - Plant Capacity in Gallons per day (GPD)

Y - Construction Costs in 1965 dollars per gallon/day

Model - $\log Y = a + b \log X$

Equation - $\log Y = 1.0922124 - 0.189806 \log X$

Valid Range of X - 1,200 to 14,800 GPD

Correlation Coefficient - -.25

Standard Error of Estimate - .216063

Ratio for Upper Limit - 1.6446

Ratio for Lower Limit - 0.6080

VALUES FOR PLOTTING

X	- Y -		
	LOWER LIMIT	EXPECTED VALUE	UPPER LIMIT
2,000	1.78	2.92	4.80
10,000	1.31	2.15	3.54
20,000	1.15	1.89	3.11

TABLE 3

CONSTRUCTION COSTS FOR
SINGLE-STAGE HIGH-RATE TRICKLING FILTER PLANTS

(Land Charges and Engineering Excluded)

Toronto E.N.R. Index (1965) = 800

MUNICIPALITY	GRAPH NO.	YEAR BUILT	TORONTO E.N.R. INDEX YEAR BUILT	PLANT CAPACITY (M.G.D.)	TOTAL COST YEAR BUILT	1965 CENTS PER GALLON PER DAY
BEAMSVILLE	1	1952	520	0.50	$ 54,000	16.64
BOWMANVILLE	2	1947	390	0.50	85,000	34.88
COBOURG	3	1949	400	1.50	250,000	33.36
DELHI	4	1949	400	0.60	130,000	43.44
FRANKFORD	5	1958	607	0.54	63,400	15.44
GEORGETOWN	6	1948	395	0.30	145,000	98.00
GRAVENHURST	7	1948	395	0.25	40,000	32.40
HAGERSVILLE	8	1949	400	0.10	45,000	90.00
OSHAWA	9	1955	543	6.0	750,000	18.40
PICTON	10	1949	400	0.50	230,000	92.00
SIOUX LOOKOUT	11	1948	395	0.50	33,000	13.36
WHITBY	12	1949	400	0.75	158,000	42.00

TABLE 3-A

CONSTRUCTION COSTS FOR SINGLE-STAGE
HIGH-RATE TRICKLING FILTER PLANTS

VARIABLES

X - Plant Capacity in million gallons per day (MGD)

Y - Construction cost in 1965 cents per gallon per day

Model - $\log Y = a + b \log X$

Equation - $\log Y = 1.4621941 - 0.334817 \log X$

Valid Range of X - .10 to 6.0 MGD

Correlation Coefficient - -.47

Standard Error of Estimate - .285882

Ratio for Upper Limit - 1.9314

Ratio for Lower Limit - .5177

VALUES FOR PLOTTING

X	- Y -		
	Lower Limit	Expected Value	Upper Limit
.1	32.44	62.66	121.02
1	15.01	28.99	55.99
5	8.75	16.91	32.66

TABLE 4

CONSTRUCTION COSTS FOR MUNICIPAL WASTE STABILIZATION PONDS

(Land Charges and Engineering Excluded)

Toronto E.N.R. Index (1965) = 800

MUNICIPALITY	GRAPH NO.	YEAR BUILT	TORONTO E.N.R. INDEX YEAR BUILT	POND SURFACE AREA (ACRES)	TOTAL COST YEAR BUILT	1965 DOLLARS PER ACRE
ALEXANDRIA	1	1962	725	42	$ 78,756	$ 2,064.00
ALMONTE	2	1962	725	45	87,760	2,152.00
ARTHUR	3	1962	725	10	28,300	3,128.00
AYLMER	4	1962	725	72	136,100	2,088.00
BRACEBRIDGE	5	1961	688	23.5	54,000	2,672.00
BRADFORD	6	1961	688	10	35,900	4,168.00
CAPREOL TWP. (HANMER)	8	1963	732	21	27,300	1,424.00
CARDIFF	7	1956	558	10	35,000	5,016.00
CHELMSFORD	9	1960	673	10	16,100	1,912.00
CHESLEY	10	1962	725	19	76,000	4,408.00
ELMVALE	11	1962	725	5	25,350	5,600.00
EXETER	12	1961	688	22	62,300	3,312.00
FAUQUIER TWP. (MOONBEAM TOWNSITE)	13	1963	732	6	9,000	1,640.00
GANANOQUE	14	1962	725	70	191,070	2,960.00
GRIMSBY TWP. (SMITHVILLE)	15	1962	725	8.5	17,800	2,320.00
GRIMSBY N. TWP.	16	1962	725	5	17,500	3,872.00
HARRISTON	17	1962	725	28	100,000	3,944.00
KINCARDINE	18	1963	732	32	60,160	2,056.00
LINDSAY	19	1962	725	111	167,800	1,664.00
LISTOWEL	20	1959	642	70	70,600	1,256.00
MATTAWA	21	1963	732	18	93,300	5,648.00
MITCHELL	22	1960	673	41.6	53,000	1,520.00
NEELON & GARSON TWPS.	23	1961	688	28.8	100,900	4,072.00
NEW HAMBURG	24	1961	688	14	32,700	2,720.00
NEW LISKEARD	25	1963	732	43	87,700	2,224.00
NIAGARA	26	1963	732	35	108,200	3,360.00
PERTH	27	1962	725	80	182,000	2,512.00

TABLE 4 (CONT'D)

MUNICIPALITY	GRAPH NO.	YEAR BUILT	TORONTO E.N.R. INDEX YEAR BUILT	POND SURFACE AREA (ACRES)	TOTAL COST YEAR BUILT	1965 DOLLARS PER ACRE
PLAYFAIR TWP. (RAMORE)	28	1961	688	2.75	$ 3,100	$ 1,312.00
POWASSAN	29	1962	725	7	32,400	5,104.00
SHELBURNE	30	1961	688	13.2	36,000	3,184.00
STIRLING	31	1959	642	12.6	35,200	3,552.00
STRATHROY	32	1961	688	60	140,000	2,712.00
SUTTON	33	1963	732	16	56,200	3,840.00
TAVISTOCK	34	1962	725	30	103,600	3,816.00
WATERFORD	35	1962	725	15	48,300	3,560.00
WAWA TWP. MICHIPICOTEN	36	1962	732	40	108,200	2,984.00
WHITNEY TWP.	37	1963	732	1.67	3,000	1,968.00
WIARTON	38	1959	642	15	37,800	3,136.00
WINCHESTER	39	1960	673	12	13,500	1,336.00
WINGHAM	40	1963	732	30	47,400	1,728.00

TABLE 4-A

CONSTRUCTION COSTS FOR MUNICIPAL WASTE STABILIZATION PONDS

VARIABLES

X - Pond Surface Area In Acres

Y - Construction Costs In 1965 Dollars per acre (dollar/acre)

Model - $\log Y = a + b \log X$

EQUATION - $\log Y = 3.5338874 - 0.078049 \log X$

Valid Range of X - 1.67 to 111 Acres

Correlation Coefficient - -.18

Standard Error of Estimate - 0.1819595

Ratio for Upper Limit - 1.5205

Ratio for Lower Limit - 0.6577

VALUES FOR PLOTTING

X	- Y -		
	Lower Limit	Expected Value	Upper Limit
10	1878.73	2856.52	4343.35
40	1683.83	2560.18	3892.75
100	1569.70	2386.65	3628.90

TABLE 5

CONSTRUCTION COSTS FOR PRIVATE & INSTITUTIONAL WASTE STABILIZATION PONDS

(Engineering and Contingencies Excluded)

Toronto E.N.R. Index (1965) = 800

MUNICIPALITY	GRAPH NO.	OWNER	APPROVAL NUMBER	CAPACITY ACRES	COST IN 1965 DOLLARS	1965 DOLLARS PER ACRE
BRUCE TWP.	1	New School	65-A-93	1.0	$ 8,554	$ 8,554
BURCHELL LAKE	2	Coldstream Copper	59-A-681	1.0	3,900	3,900
BURLINGTON	3	Tridon Mfg. Plant	64-A-802	0.50	9,300	18,600
CLINTON TWP.	4	Vineland Experimental Station	63-A-731	1.30	46,300	35,600
DENISON TWP.	5	Murray Public School	64-A-534	0.65	5,160	7,950
DUNWICH TWP.	6	Service Centre (Lot #4)	64-A-533	2.30	22,300	9,710
DUNWICH TWP.	7	B/A Service Station	64-A-552	2.0	16,240	8,120
FORT WILLIAM	8	Dept. of Public Works	64-A-268	1.73	30,600	17,500
GEORGINA TWP.	9	Recreational Park.	63-A-54	3.0	54,200	18,065
GODERICH TWP.	10	Ontario Hospital	60-A-626	6.0	50,400	8,400
HOWICK TWP.	11	Central School	63-A-458	1.0	19,400	19,400
KING TWP.	12	Ontario Hospital	63-A-492	8.0	123,200	15,400
LANCASTER TWP.	13	Shell Canada Ltd.	65-A-313	3.60	21,975	6,100
MEDORA & WOOD TWPS.	14	Cleveland House	60-A-600	5.0	6,300	1,258
MONAGHAN N. TWP.	15	Crestwood Secondary House	64-A-461	3.59	45,000	12,550

TABLE 5 (CONT'D)

MUNICIPALITY	GRAPH NO.	OWNER	APPROVAL NUMBER	CAPACITY ACRES	COST IN 1965 DOLLARS	1965 DOLLARS PER ACRE
MOORE TWP.	16	Lambton Generating Station	65-A-470	6.0	$ 49,500	$ 8,250
MORRISON TWP.	17	Rockwood Camp	64-A-442	0.875	3,550	4,050
MURRAY TWP.	18	B/A Oil Co.	63-A-500	2.0	18,800	9,400
MUSKOKA TWP.	19	Sands Inn	63-A-406	2.0	20,440	10,220
MUSKOKA TWP.	20	Beaver Creek Correctional Camp	64-A-786	1.23	13,520	11,000
NASSAGAWEYA TWP.	21	Ontario Jockey Club	62-A-347	12	41,430	3,450
NIAGARA TWP.	22	Race Track, Hotel and new Motel	64-A-28	13.60	32,900	2,420
PALMERSTON	23	Ontario Hospital	63-A-738	10.00	121,000	12,100
PECK TWP.	24	Dept. of Public Works	63-A-739	1.4	22,600	16,150
PINARD TWP.	25	H.E.P.C.	63-A-670	3.8	64,600	17,030
ROMNEY TWP.	26	Dept. of Lands & Forests	65-A-648	3.2	38,700	12,100
ST. CATHARINES	27	Administration Building (Seaway)	64-A-617	0.40	6,200	15,500
USBORNE TWP.	28	No. 1 School	64-A-251	1.0	13,310	13,310
WEST FERRIS TWP.	29	Pinewood Park Motel	62-A-922	1.0	7,120	7,120
WHITNEY TWP.	30	North East'n Hospital	64-A-684	4.0	41,400	10,350
WILLOUGHBY TWP.	31	Willo-Dell Golf Club	64-A-202	0.36	1,750	4,860

TABLE 5-A

CONSTRUCTION COSTS FOR PRIVATE
AND INSTITUTIONAL WASTE STABILIZATION PONDS

VARIABLES

X - Pond Surface Area in Acres

Y - Construction Costs in 1965 dollars per acre (dollars/acre)

Model - $\log Y = a + b \log X$

Equation - $\log Y = 4.0251815 - 0.179310 \log X$

Valid Range of X - .36 to 13.60 acres

Correlation Coefficient - -.26

Standard Error of Estimate - .294289

Ratio for Upper Limit - 1.9692

Ratio for Lower Limit - .5078

VALUES FOR PLOTTING

X	— Y —		
	Lower Limit	Expected Value	Upper Limit
1	5,381.14	10,596.96	20,867.53
2	4,752.22	9,358.44	18,428.64
10	3,560.94	7,012.48	13,808.98

TABLE 6

CONSTRUCTION COSTS FOR
EXTENDED AERATION TREATMENT PLANTS

(Land Charges and Engineering Excluded)

Toronto E.N.R. Index (1965) = 800

MUNICIPALITY	GRAPH NO.	APPROVAL NUMBER	CAPACITY G.P.D.	COST IN 1965 DOLLARS	1965 DOLLARS PER GALLON PER DAY
BURLINGTON - Burlington Sky-way Bridge	4	62-A-194	3,000,000	$ 2,090,000	$ 0.67
BURLINGTON - Canadian Canners Ltd.	1	58-A-812	3,330	19,250	5.80
BURLINGTON - Flatt Rd. Public School	2	61-A-863	5,820	21,800	3.75
BURLINGTON - Notre Dame Academy	3	64-A-287	16,650	84,000	5.05
ELORA	5	63-A-533	83,200	80,600	0.97
ESSEX - Apartment House	6	61-A-257	3,000	9,100	3.03
GLOUCESTER TWP. - Carleton County Home for the Aged	7	59-A-401	12,500	37,050	2.97
GRAVENHURST	8	64-A-566	70,000	189,000	2.70
INNISFIL TWP. - B.A. Oil Limited, Restaurant and Service Station	9	58-A-288	20,000	41,200	2.06
KENORA - Kenora District Jail	10	59-A-581	18,000	54,000	3.00
KING TWP. - Shell Oil Ltd. Restaurant	11	58-A-146	20,000	38,600	1.93
LANSDOWNE TWP. - Hill Island Motel	12	Not approved built in 1962	10,000	13,800	1.38
LOUTH TWP. - Beacon Motor Hotel	13	59-A-668	25,000	43,200	1.73

TABLE 6 (CONT'D)

MUNICIPALITY	GRAPH NO.	APPROVAL NUMBER	CAPACITY G.P.D.	COST IN 1965 DOLLARS	1965 DOLLARS PER GALLON PER DAY
LOUTH TWP. - Garden Centre Hotel	14	60-A-330	50,000	$ 51,000	$ 1.02
MARLBOROUGH TWP. - Rideau Industrial Farm	15	58-A-	50,000	56,500	1.13
MERSEA TWP. - Sun Parlour Home	16	61-A-880	22,500	32,000	1.42
MOORE TWP. - Municipality (OWRC)	17	62-A-696	320,000	234,000	0.73
PARIS - Municipality (OWRC)	18	61-A-689	500,000	255,000	0.51
PELHAM TWP. - Alsop Apartment House	20	61-A-432	4,150	16,800	4.04
PLAYFAIR TWP. - 912 ACW Squadron Station USAF	19	60-A-149	33,150	43,050	1.30
RED LAKE TWP. - P. Government Bldg.	22	62-A-718	2,500	14,000	5.60
RICHMOND - S. Carlton High School	23	61-A-826	13,700	35,900	2.62
RIDGETOWN - Western Ontario Agricultural School	24	59-A-647	25,000	55,000	2.20
ROMA TWP. - Athletic Leadership Camp	21	60-A-536	12,500	50,960	4.07
SALTFLEET TWP.	25	59-A-528	5,000	8,750	1.75
SANDWICH W. TWP. - Riviera Motor Hotel	28	62-A-861	20,800	29,780	1.42
SANDWICH W. TWP. - Rosebowl Bowling Alley	26	62-A-684	10,000	23,400	2.34
SANDWICH W. TWP. - Windsor Teacher's Coll.	27	61-A-749	24,000	41,950	1.75

TABLE 6 (CONT'D)

MUNICIPALITY	GRAPH NO.	APPROVAL NUMBER	CAPACITY G.P.D.	COST IN 1965 DOLLARS	1965 DOLLARS PER GALLON PER DAY
SHERBORNE TWP. - Ontario Forest Ranger School	29	62-A-460	25,000	55,000	2.20
SIOUX LOOKOUT - Lands & Forests Station	30	63-A-282	15,400	93,200	6.05
SMITH TWP. - Woodland Acres Subdivision	31	58-A-807	83,200	74,000	0.89
SOMBRE TWP. - O.P.P. Station	32	61-A-679	500	2,880	5.76
THESSALON - Ontario Provincial Police	33	63-A-704	1,630	17,600	10.80
VAUGHAN TWP. - Lands & Forests Research Station	34	62-A-461	6,500	13,250	2.04
WALKER TWP. - Montelth Industrial	35	61-A-77	50,000	122,000	2.44
WESTMINSTER TWP. - Municipal STP - (OWRC)	36	59-A-311	250,000	220,000	0.88
WESTMINSTER TWP. - South Land Park Subdivision	37	61-A-412	58,200	81,500	1.40
WILLIAMSBURG TWP.	38	64-A-187	3,000	35,700	11.90

TABLE 6-A

CONSTRUCTION COSTS FOR EXTENDED AERATION SEWAGE TREATMENT PLANTS

VARIABLES

X - Plant Capacity in gallons per day (GPD)

Y - Construction costs in 1965 dollars per gallon per day (dollars/GPD)

Model - $\log Y = a + b \log X$

Equation - $\log Y = 1.9063258 - 0.362818 \log X$

Valid Range of X - 500 to 3,000,000 GPD

Correlation Coefficient - -0.81

Standard Error of Estimate - .193053

Ratio for Upper Limit - 1.5597

Ratio for Lower Limit - 0.6411

VALUES FOR PLOTTING

X	- Y -		
	Lower Limit	Expected Value	Upper Limit
1,000	4.21	6.57	10.25
10,000	1.83	2.85	4.45
100,000	0.79	1.24	1.93

TABLE 7

CONSTRUCTION COSTS FOR
CONVENTIONAL ACTIVATED SLUDGE TREATMENT PLANTS

(Land Charges and Engineering Excluded)

Toronto E.N.R. Index (1965) = 800

MUNICIPALITY	GRAPH NO.	YEAR BUILT	TORONTO E.N.R. INDEX YEAR BUILT	PLANT CAPACITY (M.G.D.)	TOTAL COST YEAR BUILT	1965 CENTS PER GALLON PER DAY
AJAX	1	1954	525	1.25	$ 300,000	36.60
ALLISTON	2	1929	190	0.20	24,000	50.64
ARMOUR HEIGHTS*	53	1929	190	0.22	20,000	38.00
AURORA	3	1932	150	0.23	47,500	110.00
AURORA (complete ext'n)	4	1956	558	0.77	330,000	61.36
BAKER DOWNS*	54	1953	525	0.165	100,000	92.00
BAKER DOWNS* (complete ext'n)	55	1954	525	0.24	96,000	61.04
BRAMPTON	5	1952	520	1.00	260,000	40.00
BRAMPTON	6	1958	607	1.00	480,000	63.20
BRAMPTON (complete ext'n)	7	1961	688	1.00	382,000	44.40
BRANTFORD	8	1958	607	12.50	2,910,000	30.72
BURLINGTON	9	1958	607	0.75	216,100	38.08
CALEDONIA	10	1954	525	0.15	90,000	91.20
CHIPPAWA	11	1955	543	0.30	122,000	60.00
CLINTON	12	1947	390	0.25	74,300	62.20
COPPER CLIFF	13	1958	607	1.50	467,000	41.12
DELRAY *	56	1952	520	0.72	225,000	48.40
DON MILLS*	57	1953	522	0.40	162,000	62.08
DUNDAS	14	1960	673	1.25	334,800	31.94
ETOBICOKE	58	1950	400	3.00	520,000	34.64
FERGUS	15	1958	607	0.60	286,000	62.88
GALT	16	1961	688	5.00	1,284,500	29.92
GEORGETOWN	17	1959	642	1.50	559,800	46.24
GLENDALE *	59	1950	400	1.50	360,000	48.00

TABLE 7 (CONT'D)

MUNICIPALITY	GRAPH NO.	YEAR BUILT	TORONTO E.N.R. INDEX YEAR BUILT	PLANT CAPACITY (M.G.D.)	TOTAL COST YEAR BUILT	1965 CENTS PER GALLON PER DAY
GRIMSBY	18	1929	190	0.25	32,100	54.40
GRIMSBY (complete ext'n)	19	1947	390	0.30	75,000	51.20
GUELPH	20	1957	596	3.50	1,392,600	53.44
GWENDOLAN *	60	1948	395	0.15	60,000	80.80
HIGHLAND CREEK*	61	1954	525	4.00	1,200,000	45.68
HUMBER *	62	1956	558	50.00	17,500,000	50.16
HUNTSVILLE	21	1958	607	0.25	190,000	100.00
INGERSOLL	22	1949	400	0.70	185,300	52.96
JANE-WILSON*	63	1949	400	0.15	80,000	106.40
KITCHENER (Spring Valley)	23	1925	195	0.90	69,000	31.52
LONDON (Westend complete ext'n)	24	1962	725	11.30	6,277,000	60.40
LONDON TWP. (Adelalde St.)	25	1957	596	1.00	719,400	96.00
LONDON TWP. (Slfton-Oxford Street)	26	1959	642	0.60	200,000	41.28
LONDON TWP. (Unlversity Helghts)	27	1959	642	0.26	142,000	69.36
MAIN (Ashbridge)*	64	1958	607	120.00	51,575,000	56.80
MARKHAM	28	1959	642	0.34	270,000	99.20
MILTON (complete ext'n)	29	1957	596	0.34	150,000	59.20
MOUNT FOREST	30	1948	395	0.25	108,500	88.00
NEPEAN TWP.	31	1960	673	1.50	720,000	57.12
NORTH BAY	32	1959	642	4.00	891,900	27.76
OAKVILLE	33	1947	390	0.75	104,000	28.48
ORILLIA	34	1948	395	2.00	341,300	34.64
OTTAWA (Urbandale)	35	1959	642	0.80	400,000	62.40

TABLE 7 (CONT'D)

MUNICIPALITY	GRAPH NO.	YEAR BUILT	TORONTO E.N.R. INDEX YEAR BUILT	PLANT CAPACITY (M.G.D.)	TOTAL COST YEAR BUILT	1965 CENTS PER GALLON PER DAY
PETERBOROUGH	36	1949	400	4.80	583,000	24.64
PICKERING TWP. (Bay Ridges)	37	1960	673	1.25	570,000	54.32
PHARMACY *	65	1928	200	1.00	77,000	30.88
PORT COLBORNE (East Plant)	38	1955	543	0.85	350,000	60.80
PORT COLBORNE (West Plant)	39	1960	673	0.90	532,800	70.24
PORT HOPE	40	1956	558	1.00	375,000	53.84
PRESTON	41	1961	688	1.80	605,000	39.12
RICHMOND HILL (complete ext'n)	42	1957	596	0.97	350,000	48.56
RIVERSIDE & SANDWICH EAST	43	1962	725	4.00	1,738,000	47.84
ST. THOMAS #1	44	1924	200	1.5	80,000	21.36
ST. THOMAS #2	45	1953	525	1.5	391,000	39.76
SIMCOE	46	1955	543	1.0	186,400	27.44
SIMCOE (complete ext'n)	47	1962	725	1.4	553,000	43.60
STONEY CREEK	48	1950	400	0.18	80,000	88.00
STOUFFVILLE	49	1956	558	0.675	-	43.36
STRATFORD (complete ext'n)	50	1957	596	4.00	647,600	21.76
STREETSVILLE	51	1957	596	0.80	336,000	56.40
TODMORDEN *	67	1926	200	1.75	195,670	44.32
TILLSONBURG	52	1959	642	0.66	324,500	60.64
TORONTO TWP. (Clarkson)	69	1956	558	1.00	275,000	39.36
TORONTO TWP. (Dixie)	68	1954	525	0.40	160,000	60.96
TORONTO TWP. (Lakeview)	70	1960	673	5.00	1,922,000	45.68
TORONTO TWP. (Malton) (Complete ext'n)	71	1957	596	0.40	235,000	78.80

TABLE 7 (CONT'D)

MUNICIPALITY	GRAPH NO.	YEAR BUILT	TORONTO E.N.R. INDEX YEAR BUILT	PLANT CAPACITY (M.G.D.)	TOTAL COST YEAR BUILT	1965 CENTS PER GALLON PER DAY
TRAFALGAR TWP.	72	1955	542	2.50	-	43.28
WATERLOO (complete ext'n)	73	1959	642	4.00	660,000	20.56
WHITBY	74	1959	642	1.25	540,000	53.92
WOODSTOCK	75	1921	195	1.50	80,000	21.92
WOODSTOCK	76	1955	543	2.50	280,000	16.56

* Operated by or taken out of service by Metropolitan Toronto.

TABLE 7-A

CONSTRUCTION COSTS FOR CONVENTIONAL ACTIVATED SLUDGE PLANTS

VARIABLES

X - Plant Capacity in million gallons per day (MGD)

Y - Construction Costs in 1965 cents per gallon per day (cents/GD)

Model - $\log Y = a + b \log X$

Equation - $\log Y = 1.6909518 - 0.159659 \log X$

Valid Range of X - .15 to 120.00 MGD

Correlation Coefficient - -.48

Standard Error of Estimate - .159965

Ratio for Upper Limit - 1.4453

Ratio for Lower Limit - 0.6919

VALUES FOR PLOTTING

X	- Y -		
	Lower Limit	Expected Value	Upper Limit
1	33.97	49.09	70.95
10	23.52	33.99	49.13
100	16.28	23.53	34.01

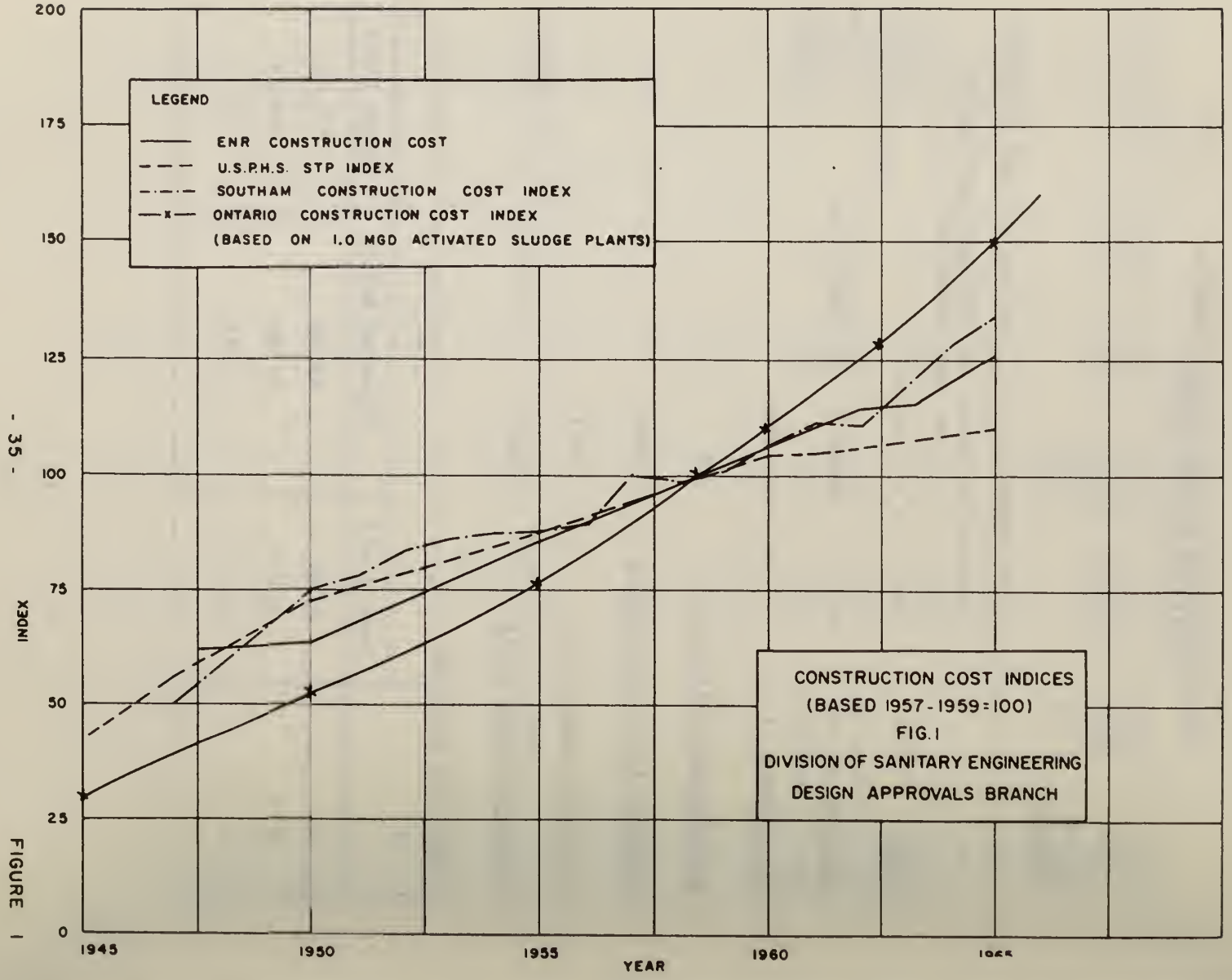
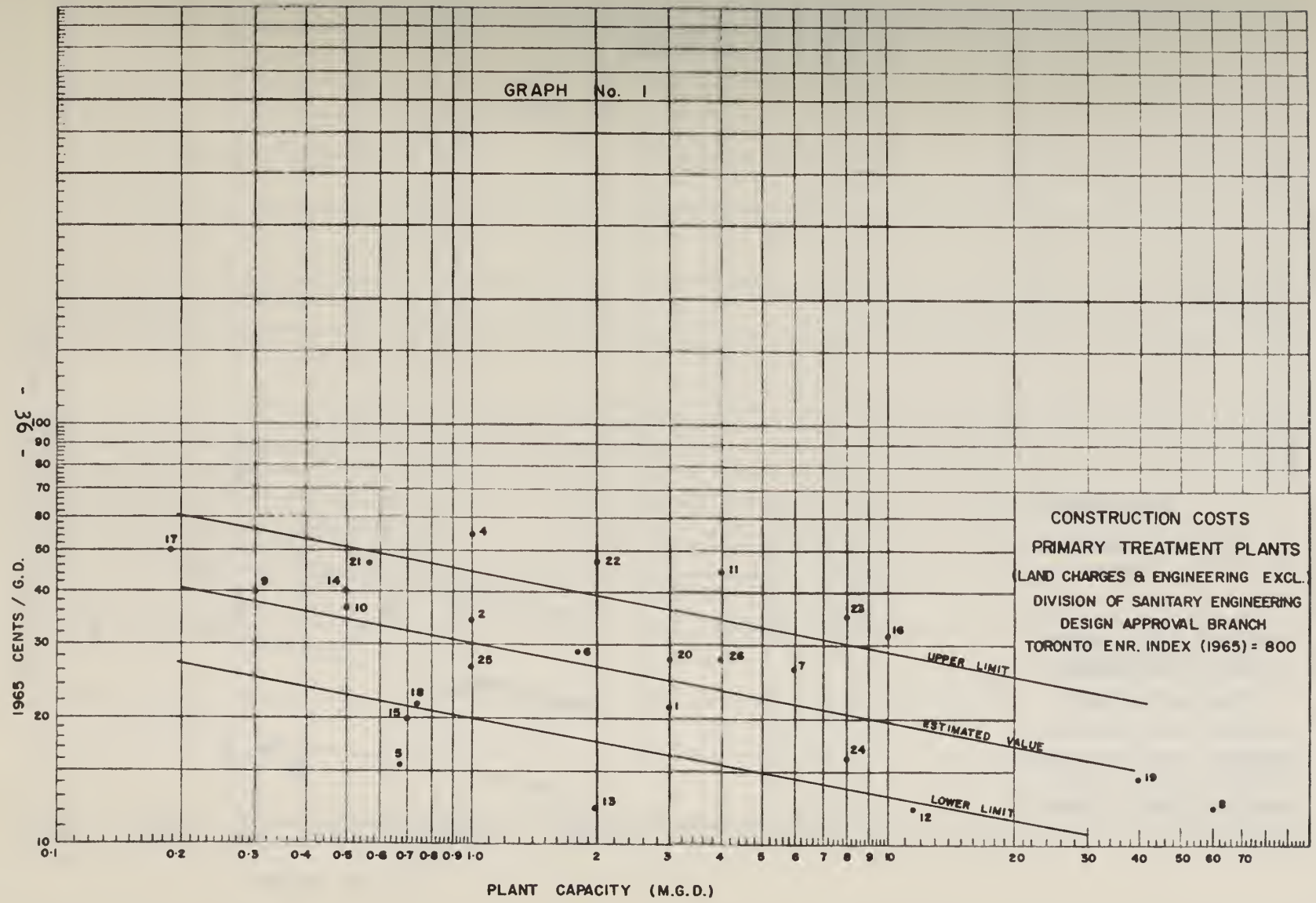
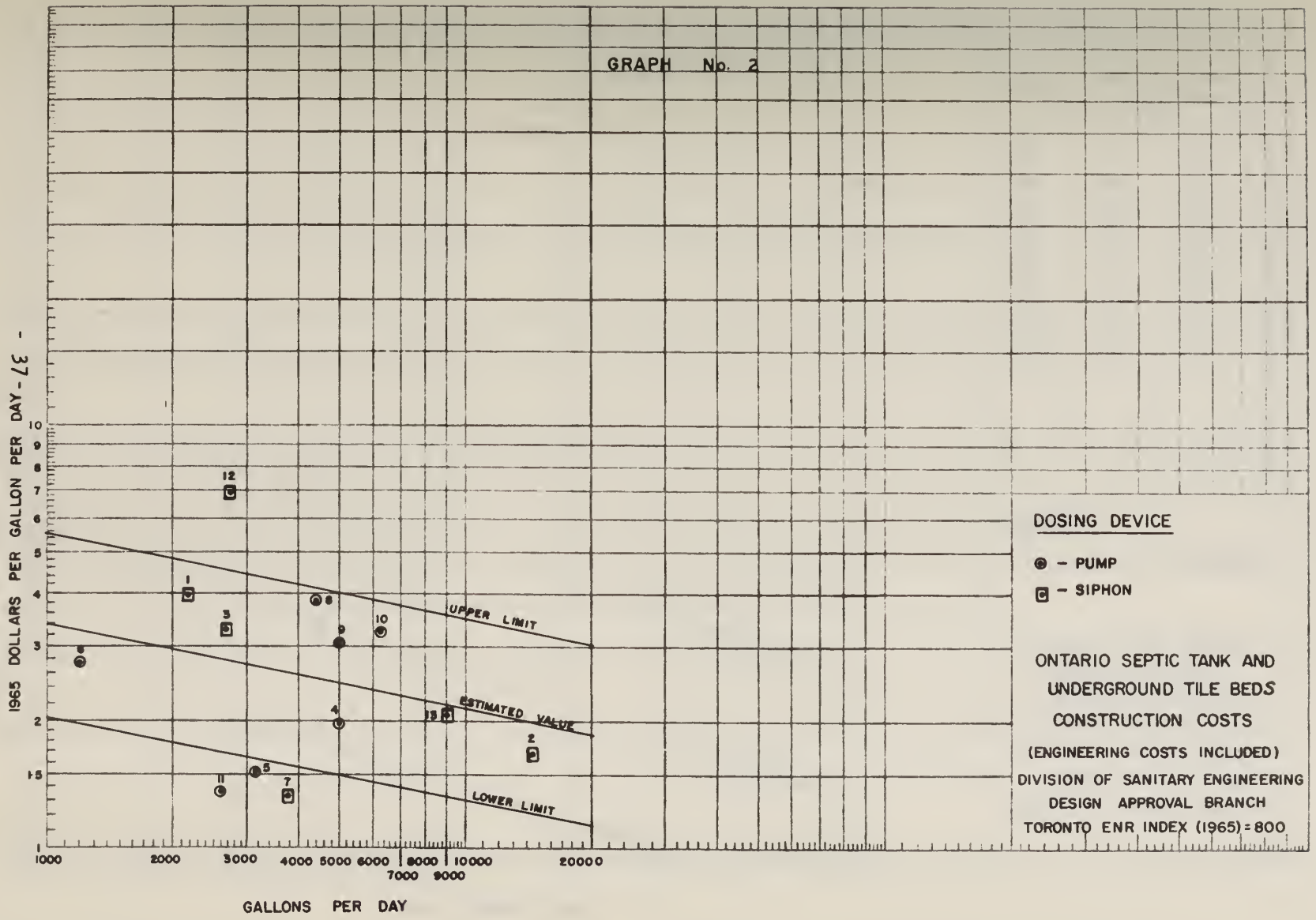

LEGEND
ENR CONSTRUCTION COST
U.S.P.H.S. STP INDEX
SOUTHAM CONSTRUCTION COST INDEX
ONTARIO CONSTRUCTION COST INDEX
(BASED ON 1.0 MGD ACTIVATED SLUDGE PLANTS)
CONSTRUCTION COST INDICES
(BASED 1957-1959=100)
FIG. 1
DIVISION OF SANITARY ENGINEERING
DESIGN APPROVALS BRANCH
INDEX
YEAR
200
175
150
125
100
75
50
25
0
1945
1950
1955
1960

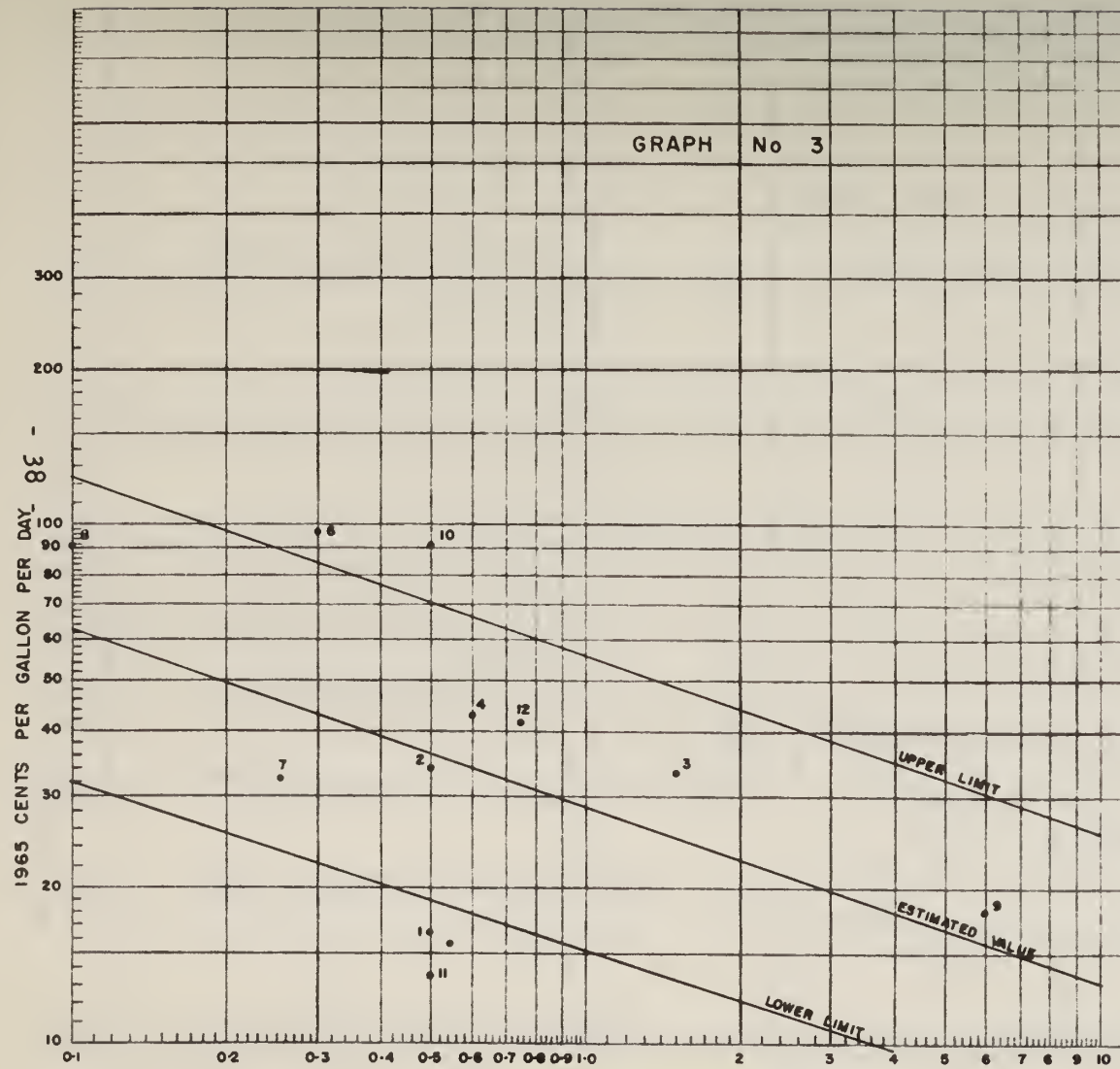
FIGURE 1


GRAPH No. 1
CONSTRUCTION COSTS
PRIMARY TREATMENT PLANTS
(LAND CHARGES & ENGINEERING EXCL.)
DIVISION OF SANITARY ENGINEERING
DESIGN APPROVAL BRANCH
TORONTO ENR. INDEX (1965) = 800
UPPER LIMIT
ESTIMATED VALUE
LOWER LIMIT
1965 CENTS / G.D.
PLANT CAPACITY (M.G.D.)
0·1
0·2
0·3
0·4
0·5
0·6
0·7
0·8
0·9
1·0
2
3
4
5
6
7
8
9
10
20
30
40
50
60
70
10
20
30
40
50
60
70
80
90
100


GRAPH No. 2
1965 DOLLARS PER GALLON PER DAY
GALLONS PER DAY
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
20000
UPPER LIMIT
ESTIMATED VALUE
LOWER LIMIT
DOSING DEVICE
⊕ - PUMP
⊡ - SIPHON
ONTARIO SEPTIC TANK AND UNDERGROUND TILE BEDS CONSTRUCTION COSTS
(ENGINEERING COSTS INCLUDED)
DIVISION OF SANITARY ENGINEERING
DESIGN APPROVAL BRANCH
TORONTO ENR INDEX (1965) = 800

GRAPH No 3

ENR YEAR	COST US CITY 20 AV.S.	INDEX TORONTO
1913	100	——
1920	251	225
1925	207	195
1930	203	170
1935	196	165
1940	242	200
1945	308	260
1950	510	400
1955	660	543
1960	631	673
1962	879	735
1963	900	752



LEGEND

ONTARIO – ·2 3· (12 PLANTS)

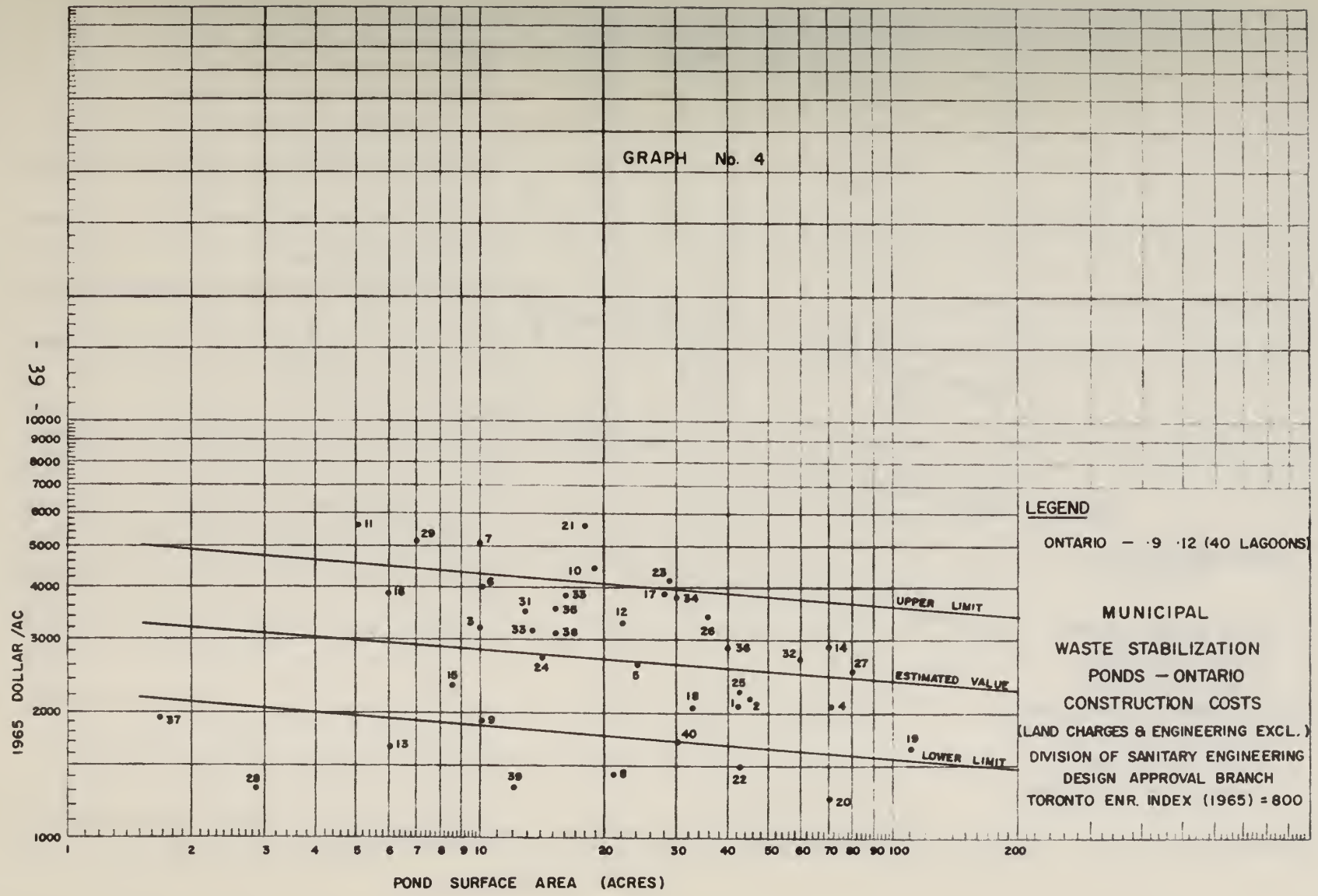
TRICKING FILTER SEWAGE TREATMENT PLANTS CONSTRUCTION COSTS

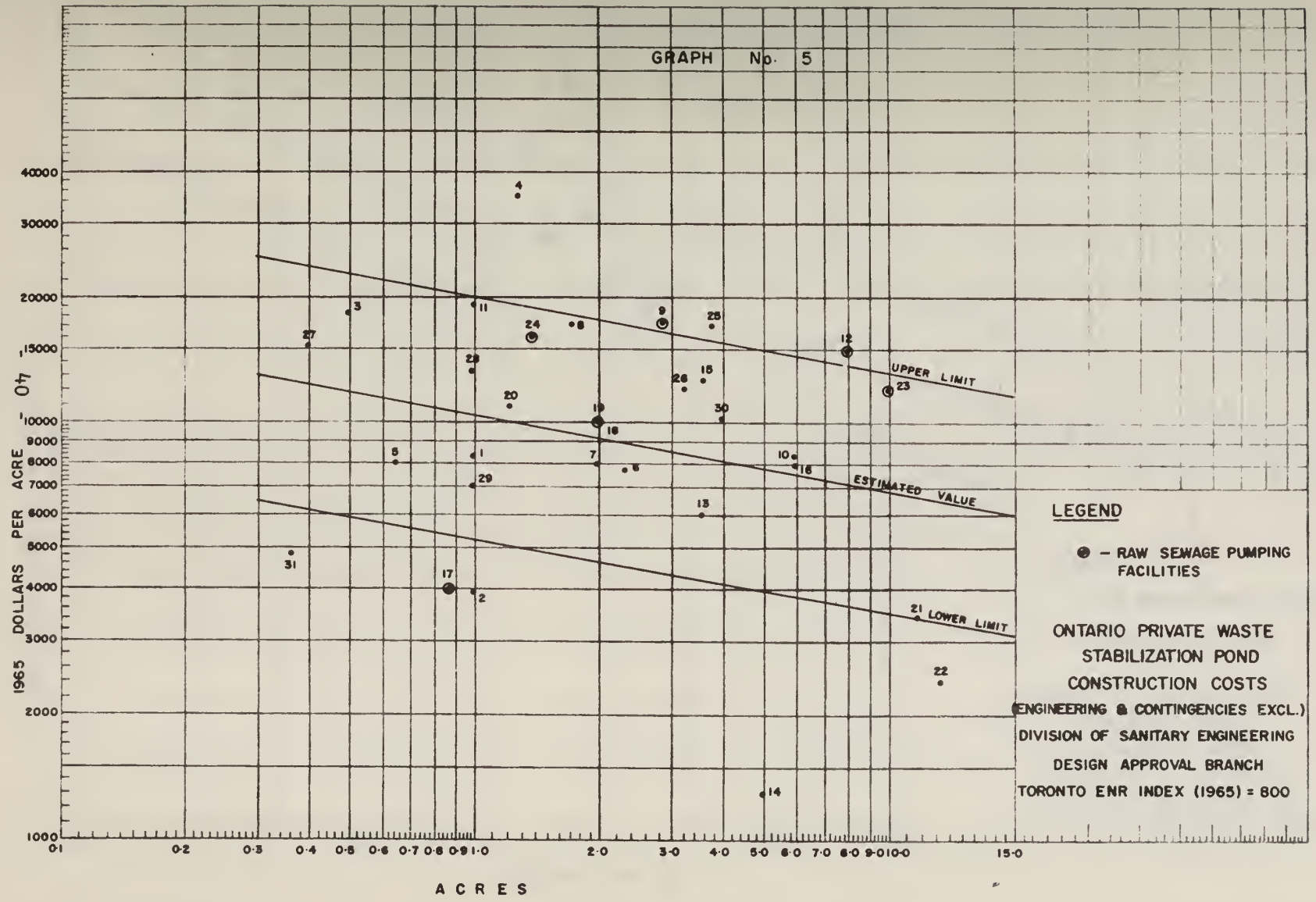
(LAND CHARGES & ENGINEERING EXCL.)

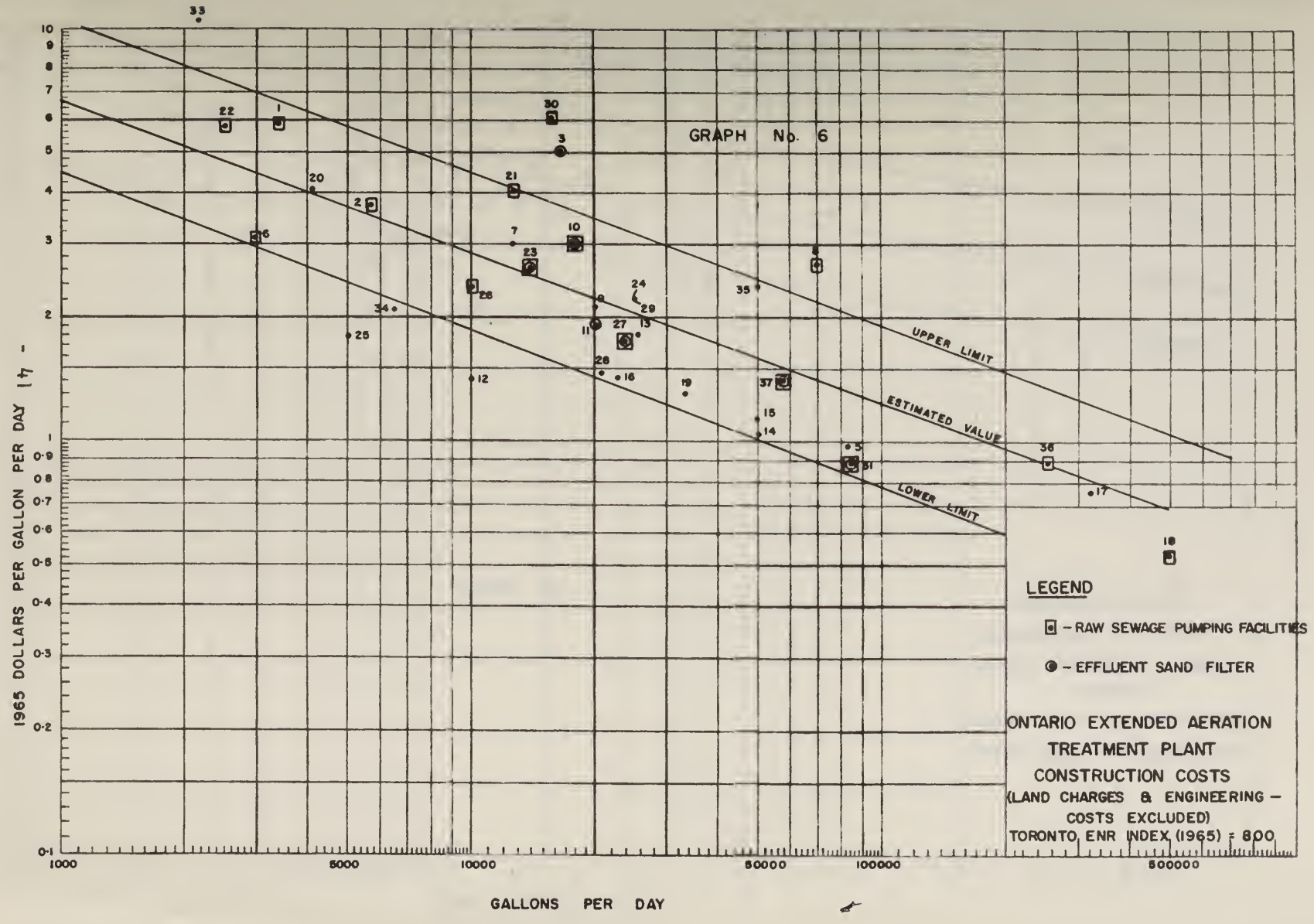
DIVISION OF SANITARY ENGINEERING

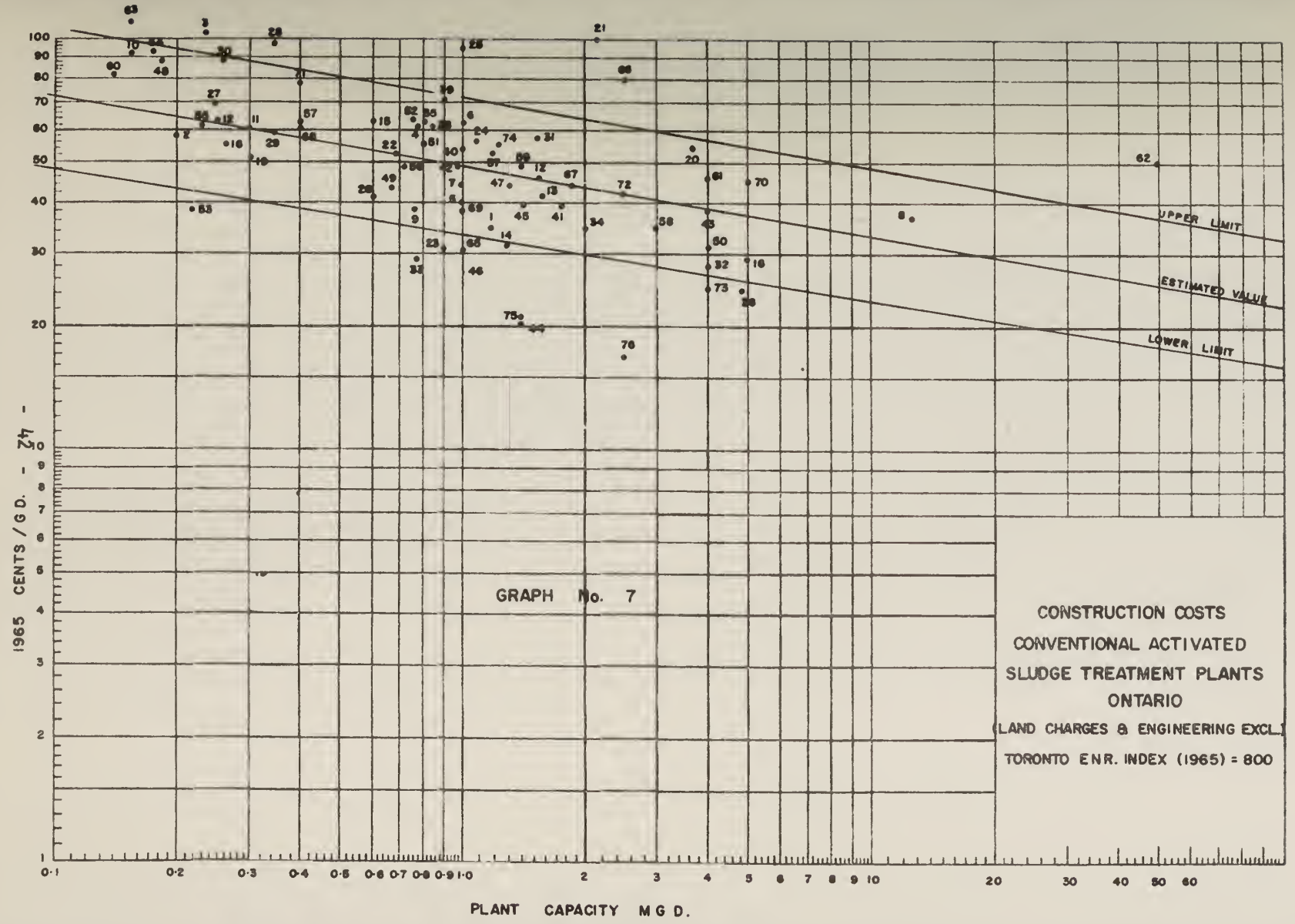
DESIGN APPROVAL BRANCH

TORONTO ENR. INDEX (1965) = 800


GRAPH No. 4
1965 DOLLAR/AC
POND SURFACE AREA (ACRES)
UPPER LIMIT
ESTIMATED VALUE
LOWER LIMIT
LEGEND
ONTARIO — ·9 ·12 (40 LAGOONS)
MUNICIPAL
WASTE STABILIZATION
PONDS — ONTARIO
CONSTRUCTION COSTS
(LAND CHARGES & ENGINEERING EXCL.)
DIVISION OF SANITARY ENGINEERING
DESIGN APPROVAL BRANCH
TORONTO ENR. INDEX (1965) = 800


GRAPH No. 5
1965 DOLLARS PER ACRE - 0+7
ACRES
UPPER LIMIT
ESTIMATED VALUE
LOWER LIMIT
LEGEND
● – RAW SEWAGE PUMPING FACILITIES
ONTARIO PRIVATE WASTE STABILIZATION POND CONSTRUCTION COSTS
(ENGINEERING & CONTINGENCIES EXCL.)
DIVISION OF SANITARY ENGINEERING
DESIGN APPROVAL BRANCH
TORONTO ENR INDEX (1965) = 800


GRAPH No. 6
1965 DOLLARS PER GALLON PER DAY
GALLONS PER DAY
UPPER LIMIT
ESTIMATED VALUE
LOWER LIMIT
LEGEND
- RAW SEWAGE PUMPING FACILITIES
- EFFLUENT SAND FILTER
ONTARIO EXTENDED AERATION TREATMENT PLANT
CONSTRUCTION COSTS
(LAND CHARGES & ENGINEERING - COSTS EXCLUDED)
TORONTO, ENR INDEX, (1965) = 800


1965 CENTS / G.D. - 47 -
PLANT CAPACITY M G D.
UPPER LIMIT
ESTIMATED VALUE
LOWER LIMIT
GRAPH No. 7
CONSTRUCTION COSTS
CONVENTIONAL ACTIVATED
SLUDGE TREATMENT PLANTS
ONTARIO
(LAND CHARGES & ENGINEERING EXCL.)
TORONTO E.N.R. INDEX (1965) = 800